Amal Naji & Amal Abdullah

M150

DATA, COMPUTING and INFORMATION

11 Computing in the wild

Introduction

- Computers and computer-enhanced systems, like other tools, allow us to extend our human reach into the world, thereby enabling us to gain some measure of control over the natural wildness it contains.
- However, the use of technology and computers in order to contain one kind of wildness, can give rise to another kind of wildness.
- There are wild systems that are unpredictable, uncontrollable and irrational, including those in which technology and computers are present or are completely absent.
- The title of this unit, Computing in the wild, has been chosen to emphasize this.

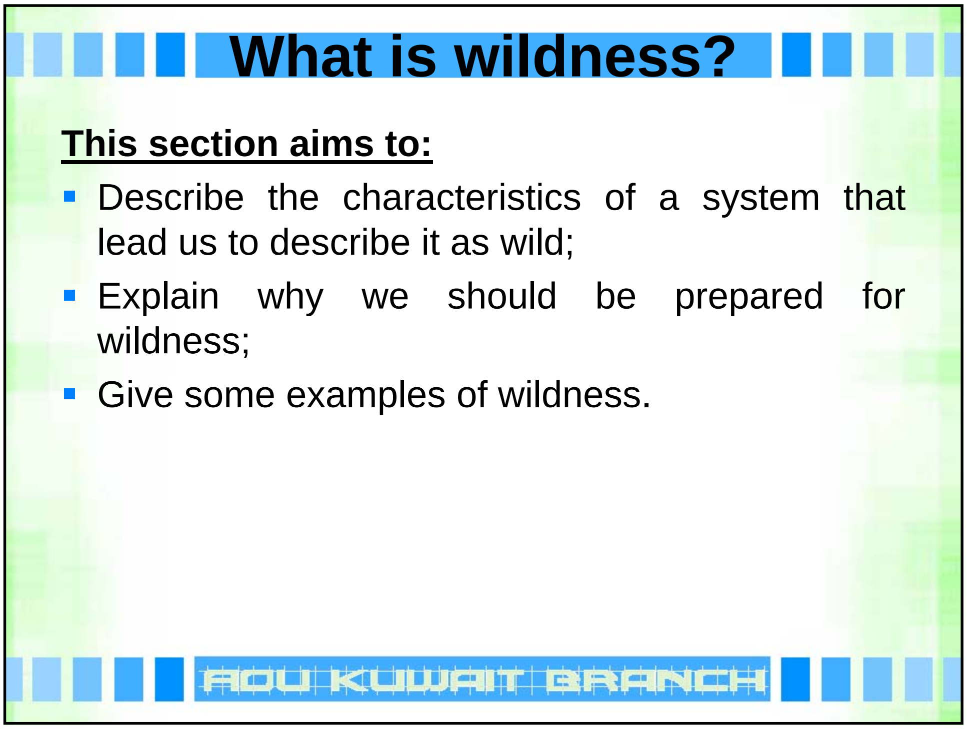
Introduction

- In Block 1, you studied how computers can be used to capture aspects of the world as representations of data.
- In Block 2, you studied how computers can be used to transform representations of input data into output data.
- In Block 3, you will study how data can be transformed into information through interaction between humans and computers.

Introduction

This unit aims to:

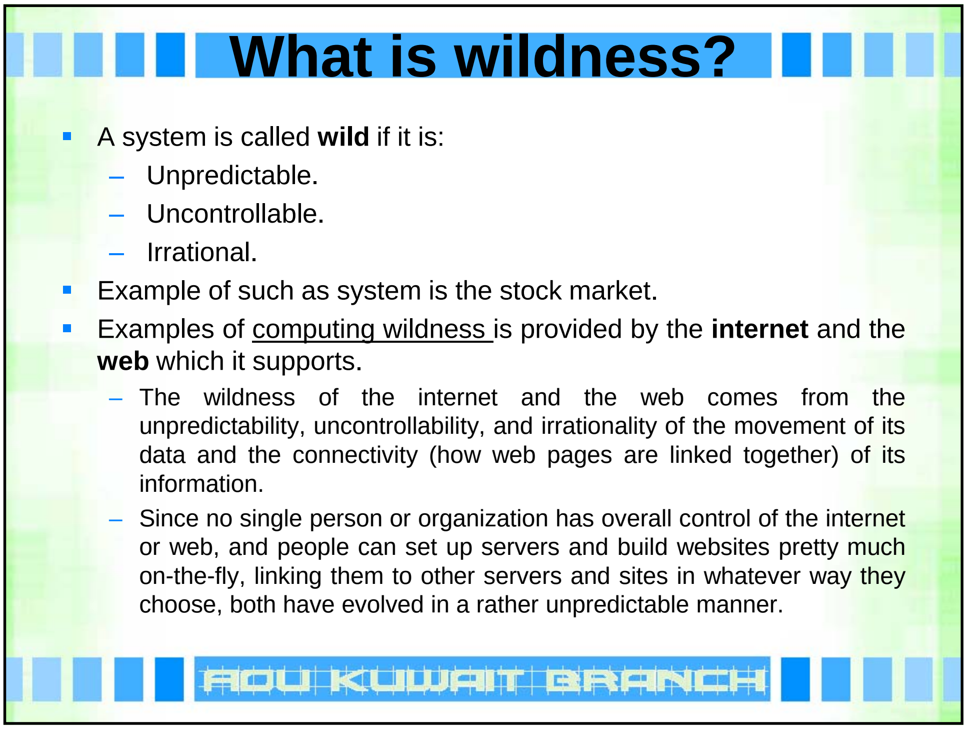
- Introduce the idea of wildness in a system;
- Show how human beings can extend their reach in the world in space, time, perception and action by using computers and computer-enhanced technologies;
- Introduce the idea of agency and how computers can act as agents for human beings; this leads on to the ideas of responsibility, delegation and trust, and of accepting the reliability of computers;
- Explain the information loop which allows data to be transformed into information and introduce the idea of emergent chaos which may generate unexpected wildness.



What is wildness?

This section aims to:

- Describe the characteristics of a system that lead us to describe it as wild;
- Explain why we should be prepared for wildness;
- Give some examples of wildness.



What is wildness?

- A system is called **wild** if it is:
  - Unpredictable.
  - Uncontrollable.
  - Irrational.
- Example of such as system is the stock market.
- Examples of computing wildness is provided by the **internet** and the **web** which it supports.
  - The wildness of the internet and the web comes from the unpredictability, uncontrollability, and irrationality of the movement of its data and the connectivity (how web pages are linked together) of its information.
  - Since no single person or organization has overall control of the internet or web, and people can set up servers and build websites pretty much on-the-fly, linking them to other servers and sites in whatever way they choose, both have evolved in a rather unpredictable manner.

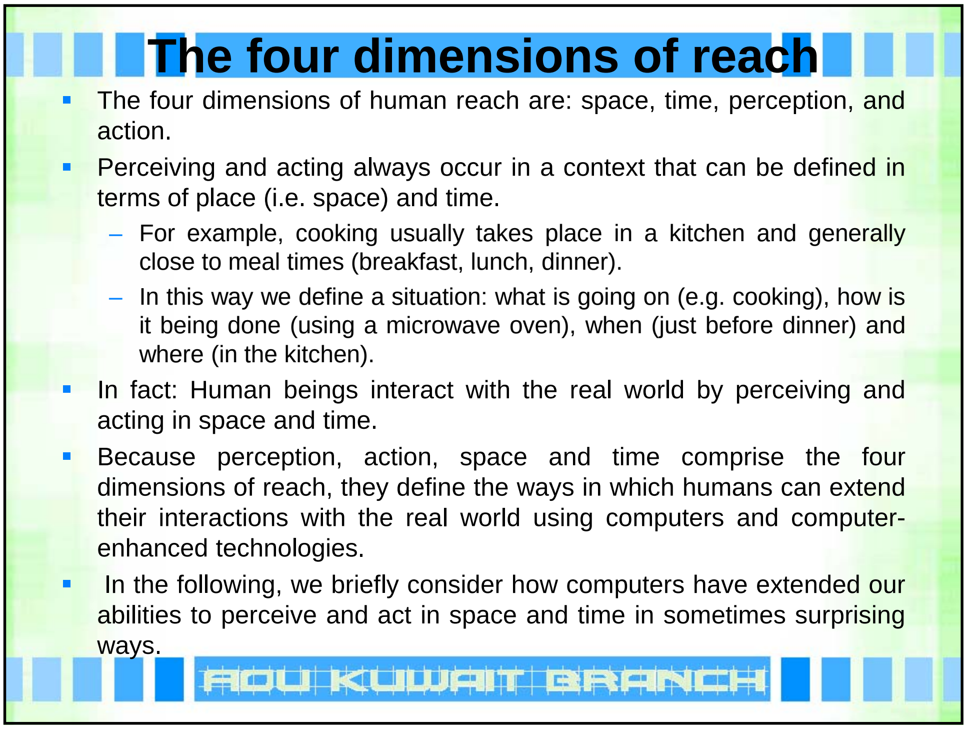
What is wildness?

Wildness can come from computers and their use. Examples are:

- **Computer viruses**: Programs that 'infect' other programs, often by embedding a copy of themselves inside.
- **Spam email**: Marketing and other messages that are unsolicited.
- **Robots**: Some are autonomous machines that interact with their (often unpredictable) external environment and behave in ways that are unpredictable and difficult to control.
- **Artificial neural networks**: Computers or computer programs that are designed to mimic the way that a human brain works.
- **Genetic algorithms**: Collection of search algorithms based on the mechanics of natural selection and genetics. They generate solutions to problems (based on controlled application of random operations in a population of data) that cannot readily be explained or predicted.

The four dimensions of reach

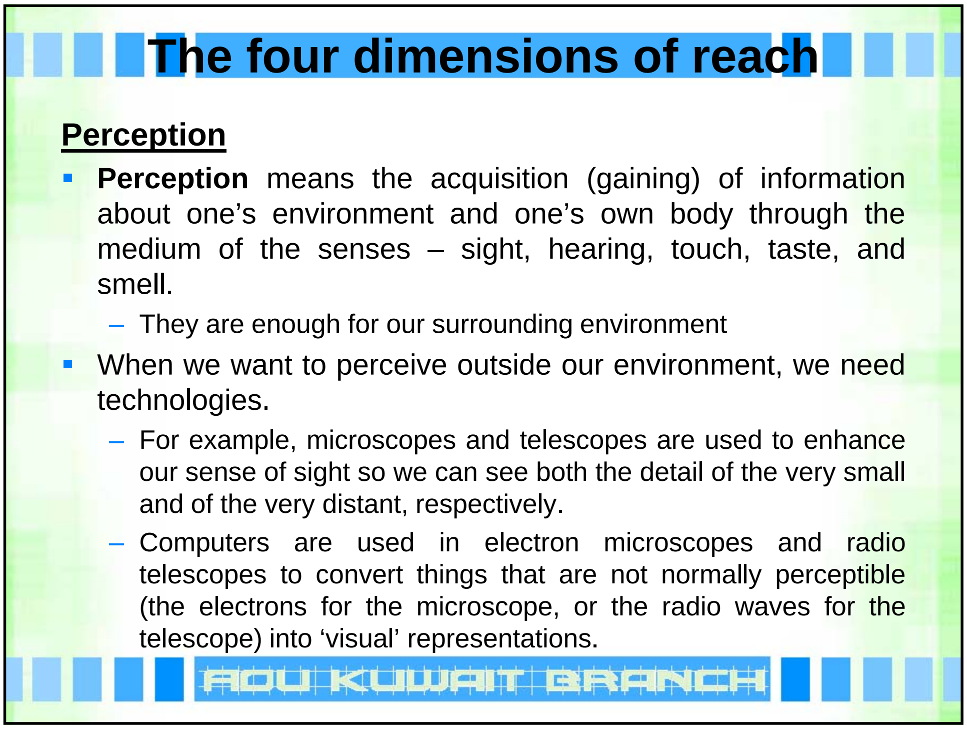
- In this section you will study how our human need to control and predict the vast and often wild and unpredictable world has led to the development of computers and computer-enhanced technology.
- This section aims to:
  - Describe the four dimensions of reach;
  - Give some examples of how human beings' reach has been extended.



The four dimensions of reach

- The four dimensions of human reach are: space, time, perception, and action.
- Perceiving and acting always occur in a context that can be defined in terms of place (i.e. space) and time.
  - For example, cooking usually takes place in a kitchen and generally close to meal times (breakfast, lunch, dinner).
  - In this way we define a situation: what is going on (e.g. cooking), how is it being done (using a microwave oven), when (just before dinner) and where (in the kitchen).
- In fact: Human beings interact with the real world by perceiving and acting in space and time.
- Because perception, action, space and time comprise the four dimensions of reach, they define the ways in which humans can extend their interactions with the real world using computers and computer-enhanced technologies.
- In the following, we briefly consider how computers have extended our abilities to perceive and act in space and time in sometimes surprising ways.

AOU KUWAIT BRANCH



The four dimensions of reach

Perception

- **Perception** means the acquisition (gaining) of information about one's environment and one's own body through the medium of the senses – sight, hearing, touch, taste, and smell.
  - They are enough for our surrounding environment
- When we want to perceive outside our environment, we need technologies.
  - For example, microscopes and telescopes are used to enhance our sense of sight so we can see both the detail of the very small and of the very distant, respectively.
  - Computers are used in electron microscopes and radio telescopes to convert things that are not normally perceptible (the electrons for the microscope, or the radio waves for the telescope) into 'visual' representations.

AOU KUWAIT BRANCH

The four dimensions of reach

Actions

- **Actions** are of two types:

1. Technologically unaided
   - Any action that is human induced using only the body’s capacity without any instrument.
   - Example: Circles drawn in the sand by a finger, walking, jogging and running are all unaided.
2. Technologically enhanced
   - When instruments are involved to extend the human body capacity and to produce a human–machine system requiring human–machine interaction.
   - Examples: circles drawn with pencil and compasses, roller-skating, cycling, and driving are all enhanced.

The four dimensions of reach

- By definition, for unaided action the human is, of course, in control.
- Mostly, the human remains in control for enhanced action too.
- However, there are a few examples of enhanced actions where the human surrenders control.
- Consider, for example, a pacemaker or a kidney dialysis machine. Both extend our capacity to act, but in such a way that control is handed over to a machine that can act autonomously, i.e. in an independent, self-directed manner.
- Because we relinquish some part of our control, we need to be able to trust the machine.

The four dimensions of reach

Space

- Humans have a great history of reaching far into atomic and stellar spaces.
  - Using rockets, we have explored the space of the solar system.
  - Using electron microscopes and radio telescopes we have reached further into microscopic and distant space that we cannot see unaided.
- Other new types of space that exist because of computers are:
  - The space that exists on the hard disk of your computer and on a course CD-ROM.
  - Spaces created using software applications such as spreadsheets and databases.
  - The internet, with its information spaces.
  - Cyberspace: is an infinite computer-generated artificial world – a ‘virtual reality’ – where humans navigate in an information-based shared space.
- Computer-based spaces allow people who are physically separated by large distances to come together.

The four dimensions of reach

Time

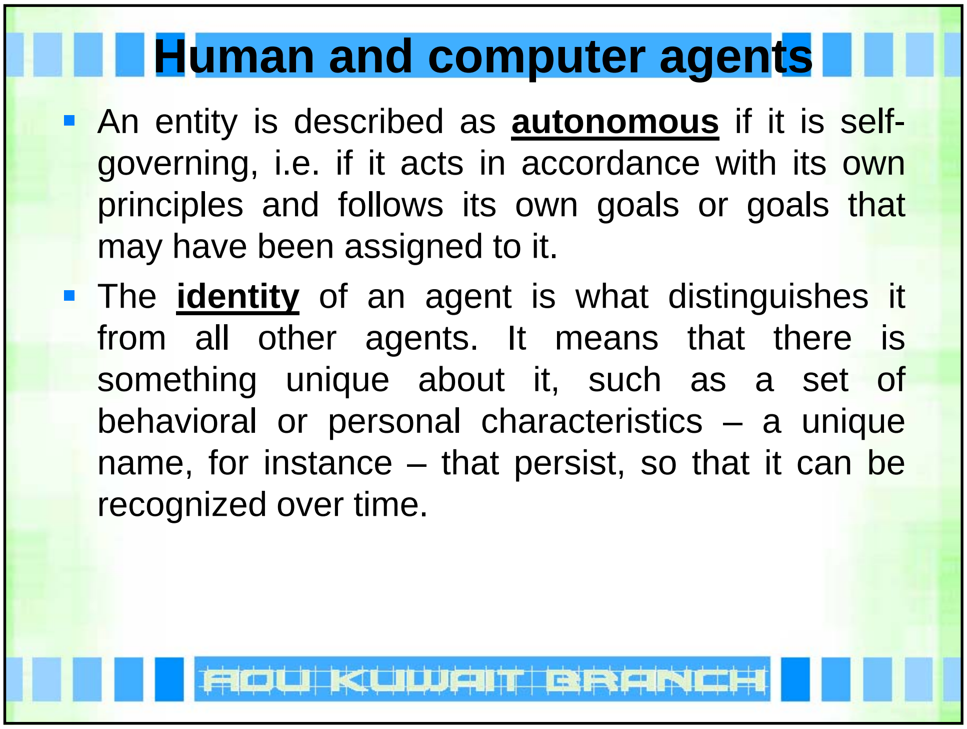
- Humans have always been interested in the passage of time, and technologies that improve our grasp of time.
- Examples include:
  - Obelisks, sundials, hourglasses, water clocks.
  - Mechanical clocks that make use of a balance wheel and pendulum.
  - Modern electronic and digital clocks based on vibrating crystal or electromagnetic waves associated with the internal workings of atoms as their regulators.

Human and computer agents

- In this section, we take a closer look at the different components that make up human–computer systems with a view to understanding the different roles played by each when we extend our reach into the world through them.
- This section aims to:
  - Explain how humans and computers can act as agents;
  - Describe how computing can be thought of as interaction between humans and computers;
  - Discuss how the responsibility for an agent's decisions can be assigned;
  - Explain the role of delegation and trust in our willingness to rely on computers;
  - Explain how actions can be delegated through programming.

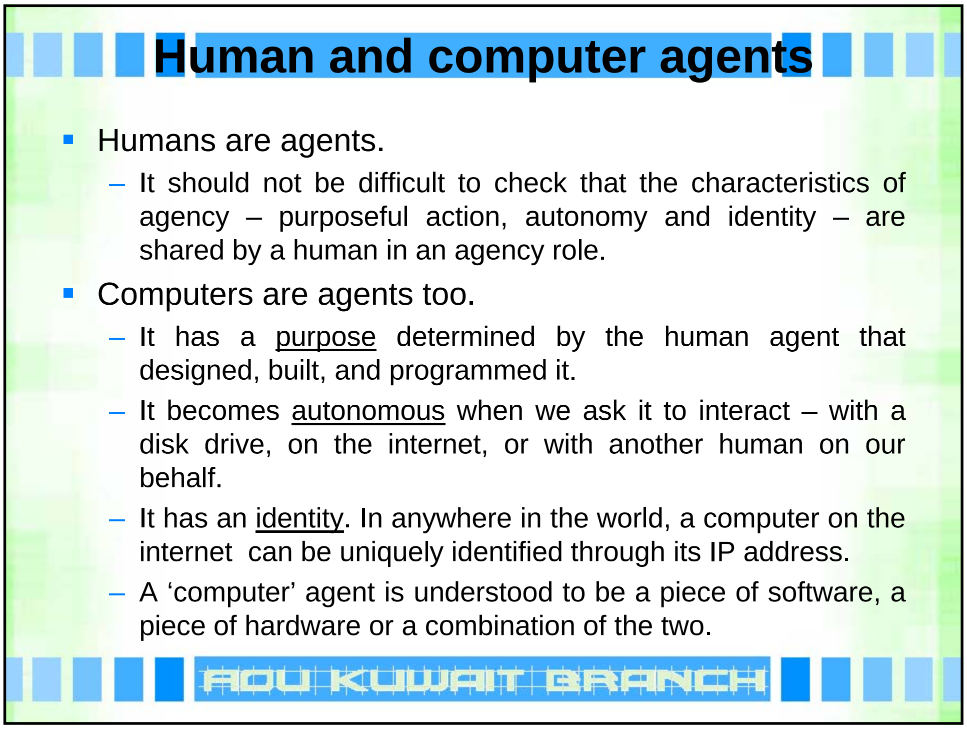
Human and computer agents

- Actions such as buying a house, booking a holiday with a travel company requires dealings with an **agent** –an estate agent and a travel agent respectively.
- Agents act **purposely** for another or for themselves.
- In acting purposely, agents bring about actions to deliver results.
- An **agent** is an entity that is able purposely to bring about a change in itself or in the world.
- In addition to acting purposely, agents are associated with two other properties: **autonomy** and **identity**.



Human and computer agents

- An entity is described as **autonomous** if it is self-governing, i.e. if it acts in accordance with its own principles and follows its own goals or goals that may have been assigned to it.
- The **identity** of an agent is what distinguishes it from all other agents. It means that there is something unique about it, such as a set of behavioral or personal characteristics – a unique name, for instance – that persist, so that it can be recognized over time.



Human and computer agents

- Humans are agents.
  - It should not be difficult to check that the characteristics of agency – purposeful action, autonomy and identity – are shared by a human in an agency role.
- Computers are agents too.
  - It has a purpose determined by the human agent that designed, built, and programmed it.
  - It becomes autonomous when we ask it to interact – with a disk drive, on the internet, or with another human on our behalf.
  - It has an identity. In anywhere in the world, a computer on the internet can be uniquely identified through its IP address.
  - A 'computer' agent is understood to be a piece of software, a piece of hardware or a combination of the two.

Human and computer agents

Computing as interaction

- With two different types of agent, humans and computers, there are four possibilities for interaction based on how the interaction is initiated:
  - Human–computer interactions: such as when you launch a software application.
  - Computer–computer interactions: such as the interaction between software applications and the operating system.
  - Computer–human interactions: such as a reminder of an appointment or task generated by an application like Microsoft Outlook.
  - Human–human interactions: such as another human opinion intervening with the work.

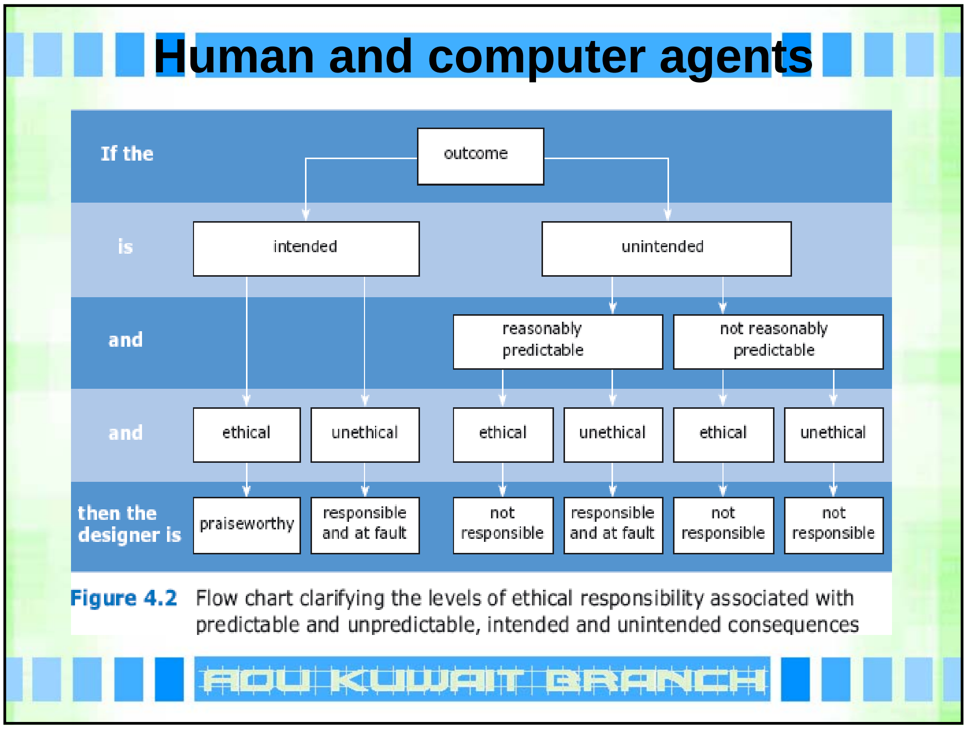
AOU KUWAIT BRANCH

Human and computer agents

Assigning responsibility for an agent's decisions

- Who should be held responsible when something goes wrong?
- Laws of ethics say that a software designer should not be held responsible for any harm resulting as an outcome of the software if the harm is:
  - Unintentional.
  - Not reasonably predictable.
  - Due to the ethical or unethical use of the computer by another. (see Figure 4.2).
- Even when the costs of making mistakes are high, the use of a computer as an agent may leave us having to bear those costs, but without being able to hold anyone else (the designer, builder or programmer) or anything else (the computer) responsible.
- In short, we can delegate to a computer our authority to do certain things, but cannot hold it responsible if it fails in this capacity. We may just have to trust the computer.

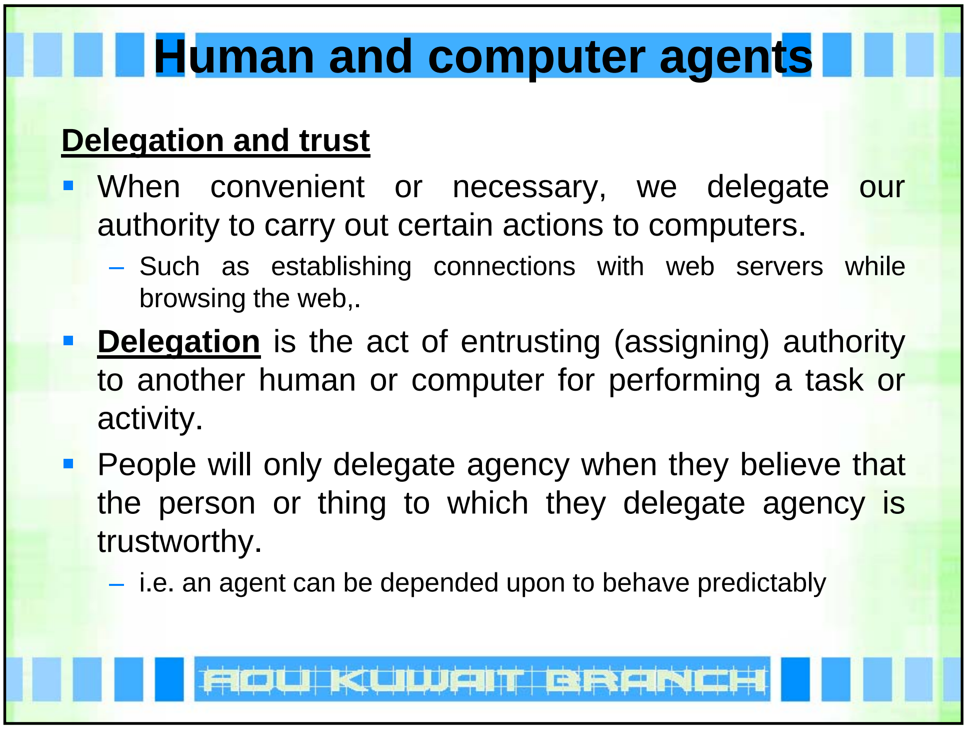
AOU KUWAIT BRANCH



Human and computer agents

Figure 4.2 Flow chart clarifying the levels of ethical responsibility associated with predictable and unpredictable, intended and unintended consequences

AOU KUWAIT BRANCH



Human and computer agents

Delegation and trust

- When convenient or necessary, we delegate our authority to carry out certain actions to computers.
  - Such as establishing connections with web servers while browsing the web,.
- **Delegation** is the act of entrusting (assigning) authority to another human or computer for performing a task or activity.
- People will only delegate agency when they believe that the person or thing to which they delegate agency is trustworthy.
  - i.e. an agent can be depended upon to behave predictably

AOU KUWAIT BRANCH

Human and computer agents

- **Trust** is a relationship between two agents in which one depends on the other to behave in an anticipated (or predictable) way. It is something that has to be earned.
- We trust because most, if not all, of the time, it enables us to carry out successfully actions that are important to us.
  - On a day-to-day basis, we trust all sorts of systems in which computers play a central role, such as PDAs, computer diaries, car engine management systems, aero-planes, power and telephone systems.
- Trust is a necessary condition for delegation.
  - We would only delegate once we had built up a relationship of trust.
  - However, often it is the other way round: we trust because we have delegated and often because we are forced to.
  - Alternatively, it might be that we trust because we believe there simply is no other alternative.

Human and computer agents

Computing in the tame

- Agency can be delegated to computers through programming.
- General purpose computers can be thought of as universal machines that become specific once they are given a specific program.
  - They can't act without a set of instructions telling them what to do.
  - To delegate to a computer means having to tell it, somehow, what to do.
- In a computing context, we refer to a **universal computer** as one that, given sufficient time and memory and the appropriate program, can simulate (mimic) any other computer whatsoever – including itself!

Human and computer agents

- As you saw before, we delegate to computers because we trust them, and we trust them because we believe that they are **reliable**.
- **Reliability** is an attribute of any computer-related component (software, or hardware, or a network, for example) that consistently produces the same results, preferably meeting or exceeding its specifications.
- Although it is not necessary to understand why an entity behaves in a reliable manner in order to trust it, the more we understand how and why it behaves in the way that it does, the more we are likely to trust it.
- Since computers are designed and constructed by human beings, their behavior is, in principle, fully understandable.
- However, this does not mean that the behavior of such systems is predictable or controllable.

Taking control

- This section aims to:
  - Define the currency of computing;
  - Explain the information loop;
  - Explain how computing in the wild can emerge.

Taking control

The currency of computing

- **Interaction** means a dynamic, contextual, causal relation between two agents.
- When agents involved include both humans and computers, then the interaction is referred to as human-computer interaction or computing.
- Interaction between humans and computers requires a certain **currency**.
- **Currency** is that within which, or on the basis of which, computer interaction can occur.
- The two basic types of computing currency are **data** and **information**.

Taking control

- In order to facilitate the exchange of data and information, a set of rules must exist so that data can be related to information, and vice versa.
  - The binary sequence, 00000011, which is a datum, can be interpreted by a human being as referring to the number 3, an item of information.
- For human–computer interaction can take place, we need to make use of both kinds of computing currency, data and information, and establish rules that enable conversion between them. However, there are costs involved.
- Currency involved in the four different kinds of interactions between human and computers:
  - human–human interactions involve information only;
  - human–computer and computer–human interactions involve both data and information;
  - computer–computer interactions involve data only.

Taking control

- You may have got the impression from reading some of the units in this course that it is the computer that converts data into information.
- However, in the view which sees computers as agents that can be used to enhance our capacity for reaching out into the world, all that a computer can do is transform data into a form from which humans can more easily extract the information they want or need.
- This means that humans play an essential role in converting data into information using computers, a role that cannot be carried out by computers themselves.
- Human beings never start with data in the context of a human–computer interaction; they always start with information and always finish with information, too.
- This could be summarized by saying that:
  - Computing as human–computer interaction is a movement from information to information.

Taking control

- The essential role of human beings is in this flow, i.e. in the conversion of information into data and data into information using computers, leads to what we call the information loop of computing shown in Figure 5.1.

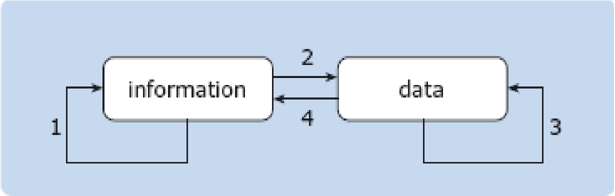


Figure 5.1 The information loop of computing

Taking control

- **The information loop is made up of four distinct activities:**

1. Transformation of information into other information based on human– human interaction.
2. Contraction of information into data via the representation of information in a form that the computer can deal with (Unit 2).
   - This involves decontextualization, i.e. a process of abstraction involving the elimination of information considered irrelevant to the task in hand.
   - To contract information into data means to remove meaning from information, and is one of the costs of computing that must be met by a human agent.

Taking control

3. Transformation of data into other data based on computer–computer interaction.
4. Expansion of data into information via interpretation by a human being.
   - This involves contextualisation, i.e. putting data in the context of other data and information considered relevant to the task in hand.
   - To expand data into information means to give meaning to data and again, is one of the costs of computing that must be met by a human agent.

- Notice that the information loop of computing both begins and ends with humans whose currency is information.

Taking control

- EXERCISE 5.2: Identify which one of the information loop activities is involved in each of the following activities.

a) Receiving and then reading the contents of an email message.
  - Expansion of data into information (Activity 4).

b) Converting a file from rich text format (.rtf) to ASCII.
  - Transformation of data into data (Activity 3).

c) Explaining to someone how to install a piece of software on their PC.
  - Transformation of information into information (Activity 1).

d) Saving a letter written using a word processor as a file in text only (.txt) format.
  - Contraction of information into data (Activity 2).

Taking control

Losing control

- We should now be in a better position to explain how the phenomenon of wild computing can arise in systems designed, built and used by humans;
  - How computing in the wild can emerge from computing in the tame.
- **Emergence** refers to any process that gives rise to one or more phenomena in a collection of parts as a consequence of the interactions between them, such phenomena displaying the characteristics of unpredictability, uncontrollability and irrationality.

Taking control

- The most obvious example of a ‘wild’ emergent computing phenomenon is the **internet** which continues to evolve in ways that are somewhat unpredictable, at least partially uncontrollable, and possibly also somewhat irrational.
- Yet another aspect of wildness and emergent computing associated with the internet is the movement of data around this technological complex.
- **Electronic mail** systems and the **web** provide other striking examples of ‘wild’ computing phenomena: however, ones that are much wilder than the internet in that they are far less predictable, controllable and rational. Why might this be the case?
- This is because the web constitutes an evolving arena for human–computer interaction based on the circulation and exchange of information as opposed to data. (Remember that the information loop of computing both begins and ends with humans whose currency is information.)

Taking control

- Computers often generate new ‘wildness’ not only because of their interactions with each other but, crucially, also because of their interactions with human beings.
- Interaction makes use of the relation of computers to human agents in order to situate computer programs in a dynamic environment.
- Since computer systems are, in fact, human–computer systems, and because humans can be a source of wildness, ‘wild’ computing often results from its human element.
- In terms of Figure 5.1, we might say that the human agent in the information loop is a source of ‘wild’ computing.
- It is a source that cannot be eliminated because computing is human–computer interaction.

Unit Summary

- In this unit:
  - You have seen how computers can be used to enhance our human capacity for reaching out into the world along four dimensions – space, time, action and perception.
  - Four different types of interaction involving humans and computers were identified and we looked at how the responsibility for performing certain actions can be delegated to computers through programming.
  - We looked at the two kinds of computing currency – data and information – and the information loop involving humans and computers that allows data to be converted into information, and vice versa.
  - Finally, we examined how the phenomenon of wild computing can emerge from computing in the tame as a consequence of the complexity of the interactions between humans and computers in the information loop.